January 4, 2007 ***Draft***
URS Project Number 28649740

Mr. Bill Youngs
RossDrulisCusenbery Architecture, Inc.
January 18294 Sonoma Highway
Sonoma, CA 95476

Re: Probabilistic Ground Motion Analysis
South San Jose Police Substation
San Jose, California

Dear Mr. Youngs,

As authorized, we have completed a probabilistic seismic hazard analysis for the proposed Police Substation site in San Jose, California. The purpose of this study is to estimate the levels of ground motion that will be exceeded at a specified probability value for a given exposure period, specifically the ground motion with a 10% chance of exceedance in 50 years (475-year return period). The ground motion is characterized by the response spectrum.

In this study, available geologic and seismologic data were used to evaluate and characterize potential seismic sources, the likelihood of earthquakes of various magnitudes occurring on those sources, and the likelihood of earthquakes producing ground motions over a specified level. The uncertainties in seismic source characterization reflect the quality of the available information.

The probabilistic seismic hazard analysis methodology used in this study allows for the explicit inclusion of a range of possible interpretations in components of the model, including seismic source characterization and ground motion estimation. The following presents the seismic source characteristics, the methodology used for the seismic hazard analysis, the attenuation relationships used in the probabilistic analyses, and the hazard results. Mr. Segaran Logeswaran, P.E., assisted in the engineering analysis, and Mr. Mark Schmoll, C.E.G, provided geologic input for the seismic site characterization.

SEISMIC SOURCE CHARACTERISTICS

The location of the site with respect to known active or potentially active faults in northern California is shown in Figure 1. The site lies adjacent to the boundary zone between the North American and Pacific tectonic plates. The faults associated with this zone are predominantly northwest trending, strike-slip faults that have right lateral slip. The San Andreas fault, which extends over 1,200 kilometers from the Gulf of California to Cape Mendocino, is the major

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fault within the plate boundary zone. The Calaveras fault is about 10 km north-east of the site. The Hayward-Rodgers Creek fault is about 24 km north-east of the site. The East Valley Thrust system including the Piercy, Silver Creek, and North East Valley Thrust faults is the closest seismic source to the site. The Piercy fault is located 1.6 km south-west of the site. The South-East extension of Hayward fault is about 6 km north-east of the site. The Foothill Thrust Belt including the Monte Vista, Shannon, Berrocal, and Cascade faults, is located 7.5 km northwest of the site. The faults within 30 kilometers of the site are particularly significant in the probabilistic evaluation of the ground motions, especially because there are several of them and some are reverse faults. A more detailed discussion of the potentially significant faults is included in Appendix A. Table A-1 provides a summary of seismic slip *R*-factors assigned by the Working Group on California Earthquake Probabilities. The parameters of potentially significant faults for the seismic hazard analysis are summarized in Table A-2. In the seismic hazard analysis, we incorporated the uncertainties associated with the seismic source models (segmentation, maximum magnitudes, and recurrence rate parameters) using a logic tree approach.

METHODOLOGY FOR SEISMIC HAZARD ANALYSIS

Seismic Hazard Model

The seismic hazard model used is based on the analytical model presented by Kulkarni and others (1979). This model is similar to other models (Cornell, 1968; McGuire, 1974, 1978; Der Kiureghian and Ang, 1977) but includes some additional features as described below. The occurrence of earthquakes on a fault is assumed to be a Poisson process. The Poisson model is widely used and is a reasonable assumption in regions where data are insufficient to provide more than an estimate of an average recurrence rate (Cornell, 1968). When there is sufficient knowledge to permit a real-time estimate of the occurrence of earthquakes, the probability of exceeding a given value can be modeled as an equivalent Poisson process in which a variable average recurrence rate is assumed. The occurrence of ground motions at the site in excess of a specified level is also a Poisson process, if:

- the occurrence of earthquakes is a Poisson process, and
- the probability that any one event will result in ground motions at the site in excess of a specified level is independent of the occurrence of other events.

The probability that a ground motion parameter "Z" exceeds a specified value "z" in a time period "t" is given by:

$$p(Z>z) = 1-e^{-\mu(z)\bullet t}$$

where $\mu(z)$ is the annual mean number (or rate) of events in which Z exceeds z. It should be noted that the assumption of a Poisson process for the number of specified events is not critical. This is because the mean number of events in time t, $\mu(Z)\bullet t$ can be shown to be a close upper bound on the probability p(Z>z) for small probabilities (less than 0.10) that generally are of interest for engineering applications. The annual mean number of events is obtained by summing the contributions from all sources, that is:

$$\mu(z) = \sum_n \mu_n(z)$$

where $\mu_n(z)$ is the annual mean number (or rate) of events on source n for which Z exceeds z at the site. Parameter $\mu_n(z)$ is given by the expression:

$$\mu_n(z) = \sum_i \sum_j \beta_n(m_i) \bullet p(R=r_j \mid m_i) \bullet p(Z>z \mid m_i,r_j)$$

where:

- $\beta_n(m_i)$ = annual mean rate of recurrence of earthquakes of magnitude increment m_i on source n;
- $p(R=r_j \mid m_i)$ = probability that given the occurrence of an earthquake of magnitude m_i on source n, r_j is the closest distance increment from rupture surface to the site;
- $p(Z>z \mid m_i,r_j)$ = probability that given an earthquake of magnitude m_i at a distance of r_j, the ground motion exceeds the specified level z.

The calculations were made using a seismic hazard computer program developed by Dr. Norman Abrahamson.

Maximum Earthquake Magnitudes

Maximum earthquake magnitudes were estimated for each fault based on our current understanding of the faults and the regional tectonic environment. Maximum magnitudes were either based on published values or estimated from empirical relationships between earthquake magnitude and fault rupture length, total length, rupture area, and maximum displacement per event (Wyss, 1979; Wells and Coppersmith, 1994). Probabilistic procedures were used to include the uncertainty in these parameters and the resulting uncertainty in the magnitude estimates. The magnitude values used in the probabilistic analysis are based on the moment magnitude scale developed by Kanamori (1977). For magnitudes between 6 and 8, the moment magnitude, M_w, is approximately equal to the surface wave magnitude, M_S (Kanamori, 1983). The maximum magnitudes for the faults are presented in Table 1.

Earthquake Recurrence

During the past 150 years, northern California has experienced several large earthquakes. However, because of the short period of the historical record relative to earthquake recurrence intervals on individual faults and the uncertainty in the locations of the older earthquakes, the seismicity data alone are insufficient to estimate recurrence on individual faults. For this reason, geologic evidence for the long term seismic slip rate on individual faults must be used.

The regional seismicity data provide estimates of the relative occurrence of various earthquake magnitudes. We have used the slip rates from the real time strain accumulation model of the Working Group on California Earthquake Probabilities (1990) to estimate the recurrence of the maximum earthquake on a fault segment and the general approach of Molnar (1979), Anderson (1979), and Anderson and Luco (1983) to arrive at the recurrence of smaller events. We have included a relatively high likelihood in our model that the San Andreas and San Gregorio faults rupture with a "characteristic" magnitude on specific segments. This model is described by Aki (1983), Coppersmith and Schwartz (1983), Schwartz and Coppersmith (1984), and the Working Group on California Earthquake Probabilities (1988, 1990).

In the probabilistic analyses, it is assumed that on a given fault or fault segment, earthquakes of a certain magnitude may occur randomly along the length of the fault or segment. The extent of the fault rupture on a fault varies with earthquake magnitude as estimated from a rupture length-magnitude relationship based on the type of faulting and fault geometry. Rupture length increases rapidly with increasing earthquake magnitude. This empirically-observed trend is important in the analysis because the larger magnitude earthquakes, having longer rupture lengths, will tend to rupture portions of the fault closer to the site.

Ground Motion Attenuation

To characterize the ground motions at a specified site as a result of the seismic sources considered in the probabilistic seismic hazard analysis, we used empirical attenuation relationships for spectral accelerations. These relationships were selected on the basis of the appropriateness of the site conditions and tectonic environment for which they were developed.

The uncertainty in ground motion attenuation was included in the probabilistic analysis by using the lognormal distribution about the median values as defined by the standard error associated with each attenuation relationship. Three standard deviations about the median value were included in the analysis.

Attenuation Relationships

To characterize the attenuation of ground motions in the probabilistic analyses, we have used empirical attenuation relationships developed for the western U.S. The following relationships were used: Abrahamson and Silva (1997), Sadigh *et al*. (1997) and Boore *et al.* (1997). These are the most commonly accepted relations in use and were weighted equally. Multiple relations were used to capture the epistemic uncertainty in ground motion attenuation.

Geologic Site Conditions

The site is located on deep alluvial sediments. The reference site condition was assumed as firm soil with a shear wave velocity of 310 m/s.

RESULTS OF THE SEISMIC HAZARD ANALYSIS

The annual mean number of events exceeding given peak acceleration levels was calculated using the methodology and input parameters described above. The results for peak ground acceleration for firm ground are presented in Figure 2; the dark solid line corresponds to the total contribution from all sources to the hazard at the site. The other lines correspond to the contributions from the individual seismic sources in the model. It is evident from this figure that the Calaveras fault, San Andreas fault, Southeast extension of Hayward fault, and East Valley Thrust system are the dominant sources of potential ground motions at the site due to their high probability of producing large events and/or proximity to the site. The analogous figure for the 1-sec spectral acceleration presented in Figure 3 shows similar contributions.

The calculated hazard curves for periods of vibration between 0 and 2 seconds were used to develop the equal-hazard horizontal acceleration response spectrum for a 10% probability of exceedance in 50 years. The spectral acceleration values obtained from the hazard curves for that probability are shown in Figure 4 together with the recommended smooth response spectrum.

LIMITATIONS

The opinions and recommendations presented in this report were developed with the standard of care commonly used in this profession. No other warranties are included, either express or implied, as to the professional advice provided.

We are pleased to have been of further service to you on this project. If you have any questions, please contact our office at your convenience.

Sincerely,

Robert K. Green, G.E. 352
Consulting Professional Engineer

Jose I. Landazuri, G.E. 501
Geotechnical Project Manager

Attachments

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FAULT CREEP (ASEISMIC SLIP) AND THE R-FACTOR

Some faults or sections of faults are thought to move in a continuous aseismic manner, i.e., they slip without generating large earthquakes. The San Juan Bautista segment of the San Andreas fault is the best example of a creeping fault segment. Fault creep has been documented along portions of the Hayward, Calaveras, San Andreas, and Concord faults in the San Francisco Bay region. However, fault creep is still poorly understood. Field evidence suggests that the distribution of weak materials in the fault zone may be important (Irwin and Barnes, 1975). The primary indicator of the presence of aseismic slip at depth is the observation of surficial fault creep (e.g., Galehouse, 1995). If surficial fault creep is not observed, there is little reason to suspect that it is occurring at seismogenic depths. If surficial fault creep is observed, aseismic slip may extend to seismogenic depths beneath that section of that fault and can account for a significant portion of the slip rate available for earthquake generation (WGCEP, 2003).

Between 3 and 10 mm/year of fault creep has been measured along the trace of the southern segment of the Hayward fault, precisely where the Hayward fault slipped in the **M** 6.8 earthquake of 21 October 1868 (WGNCEP, 1996). Clearly this amount of fault creep on the southern Hayward fault cannot extend through the seismogenic depth range. In fact, the inferred depth extent of creep varies along strike from 4 km to the bottom of the seismogenic zone (Simpson *et al*., 2001). Models require locked patches under the central portion of the Hayward fault, consistent with the earthquake in 1868, but the geometry and extent of locking under the north and south ends of the Hayward fault depend on assumptions of fault geometry. Bergman *et al*. (2000) suggested from synthetic aperture radar interferometry (InSAR) data and the presence of repeating microearthquakes that a 20-km-long section of the northern Hayward fault may be creeping at all depths, precluding the initiation of any large earthquake under that section of fault. Simpson *et al.*'s (2001) models contain 1.4 to 1.7 times more stored moment along this stretch of the Hayward fault than does the model of Burgmann *et al.* (2000). Thus, there is considerable uncertainty regarding the relative importance of aseismic slip on the Hayward fault, and on the other faults characterized by WGCEP (2003).

WGCEP (2003) accounted for aseismic slip through a seismic slip factor *R* that varies from 0, where all slip rate is accounted for by aseismic slip, to 1.0, where all of the slip rate is accounted for by earthquakes. Regional tectonic models based on geodetic observations collected in the San Francisco Bay region in the last few decades are the primary basis for determining the *R*-factors.

R is used to reduce the potential rupture area of each fault. Since earthquake magnitude is calculated from the area, *R* scales **M**. Less frequent events with larger **M** are necessary to satisfy the geologic slip rate, so the average recurrence time T decreases with decreasing *R*. That is, a decrease in *R* on a fault segment decreases the mean magnitude and the mean recurrence time for segment-rupturing earthquakes. However, this effect is not known with certainty. The effect of *R* may be to increase the mean recurrence time (i.e., with fault creep) without a change to the expected magnitude. The following table lists the R-factors assigned by WGCEP (2003) and used in this analysis.

Table A-1 *R*-Factors

Fault Segment	*R*-factor
SAF* – Santa Cruz Mtns	0.8, 0.9, 1.0
SAF – Peninsula	0.9, 1.0
SAF – North Coast	0.9, 1.0
SAF – Offshore	0.9, 1.0
Northern Hayward	0.4, 0.6, 0.8
Southern Hayward	0.4, 0.6, 0.8
Rodgers Creek	0.9, 1.0
Northern Calaveras	0.7, 0.8, 0.9
Central Calaveras	0.1, 0.3, 0.5
Southern Calaveras	0.0, 0.2, 0.4
Concord	0.2, 0.5, 0.8
Northern Green Valley	0.2, 0.5, 0.8
Southern Green Valley	0.2, 0.5, 0.8
San Gregorio North	0.8, 0.9, 1.0
San Gregorio South	0.8, 0.9, 1.0
Northern Greenville	0.8, 0.9, 1.0
Southern Greenville	0.8, 0.9, 1.0
Mount Diablo Thrust	1.0

* SAF: San Andreas fault

Given the recent development of the concept of the *R*-factor and the fact that it is not universally accepted at this time, its use in seismic hazard evaluations should be done cautiously. In this study, we have adopted *R*-factors in the probabilistic seismic hazard analysis through incorporation of the *R*-adjusted maximum magnitudes from WGCEP (2003).

The following sections provide details of the source characteristics of the sources used in the probabilistic seismic hazard model (see Table A-1 for a summary of source characteristics). It should be noted that the maximum earthquake magnitudes quoted in these sections assume complete rupture of the relevant fault segment(s). In the probabilistic analysis, these magnitudes are reduced using the *R*-factors postulated by the USGS (Table A-1).

CALAVERAS FAULT

This fault is a main component of the San Andreas system, branching off the main San Andreas fault south of Hollister, and extending northwards for approximately 120 km to die out in the area of Danville. The predominant sense of motion on the Calaveras fault is right-lateral, strike-slip. A smaller component of vertical displacement is evident in some areas along the fault trace. The Calaveras fault can be divided into two distinct sections, northern and southern, with the boundary located at Calaveras Reservoir. Oppenheimer and Lindh (1992) suggest that rupture of the entire 40-km-long northern Calaveras fault is possible and could generate a **M** 7 earthquake. The Calaveras fault has generated a number of moderate-size earthquakes in historic time, including (1) the 1861 M_L 5.9 event, (2) the 1886 M_L 5.4 event, (3) the 1897 M_L 6.2 event, (4) a probable M_L 6.5 event in 1911, (5) the 1988 M_L 5.1 Alum Rock event, (6) the 1979 M_L 5.9 Coyote Lake event, and (7) the 1984 M_L 6.2 Morgan Hill event.

To the south of Calaveras Reservoir, microseismicity clearly delineates the active trace of the fault. Little microseismicity is associated with the northern section of the fault, and only the 1861 earthquake can be attributed to this portion of the fault. This event is reported to have caused 13 km of surface rupture, extending from San Ramon to Dublin (Toppozada *et al.*, 1981). The lack of a well-defined fault and the diffuse nature of seismicity at the northern end of the San Ramon Valley suggest that the Calaveras fault may die out just to the south of Walnut Creek, with strain being transferred across the East Bay Hills and onto the Hayward fault (Aydin 1982). The northern section of the fault may, therefore, be less active than the southern section. The long-term slip rate and contemporary creep rate for the southern Calaveras fault are approximately 15 ± 3 mm/yr (WGCEP, 1999), while the northern Calaveras fault has a creep rate of approximately 6 mm/yr (Prescott and Lisowski 1983) and a long-term geologic slip rate of 6 ± 1 mm/yr (Simpson *et al.* 1999). The WGCEP (1999) suggests a recurrence interval of 359 years for a maximum earthquake of **M** 7.0 on the northern Calaveras fault. The recurrence interval for a maximum event of **M** 6.7 on the southern Calaveras fault is approximately 546 years.

Several rupture scenarios, including a floating **M** 6¼ are considered for this fault (see Section 5.2.2 table). The WGCEP (1999) assigned a **M** 7.1 and 7.3 for rupture of the south-central and central Calaveras fault segments, respectively. However, recent paleoseismic investigations on the central Calaveras fault indicate that there have been no large, surface rupturing earthquakes along this reach of the fault in the last 2,700 years (Kelson and Baldwin, 2001).

SAN ANDREAS FAULT ZONE

The dominant active fault structure in this region is the San Andreas fault. The fault extends from the Gulf of California, Mexico, to Point Delgada on the Mendocino Coast in northern California, a total distance of 1,200 km. The San Andreas fault accommodates the majority of the motion between the Pacific and North American plates. This fault is the largest active fault in California and is responsible for the largest known earthquake in Northern California, the 1906 **M** 7.9 San Francisco earthquake (Wallace, 1990). Movement on the San Andreas fault is right-lateral strike-slip, with a total offset of some 560 km (Irwin, 1990). In northern California, the San Andreas fault is clearly delineated, striking northwest, approximately parallel to the vector of plate motion between the Pacific and North American plates. Over most of its length, the San Andreas fault is a relatively simple, linear fault trace. Immediately south of the Bay, however, the fault splits into a number of branch faults or splays, including the Calaveras and Hayward faults (each is discussed below). In the Bay Area, the main trace of the San Andreas fault forms a linear depression along the Peninsula, occupied by the Crystal Springs and San Andreas Lake reservoirs. Geomorphic evidence for Holocene faulting includes fault scarps in Holocene deposits, right-laterally offset streams, shutter ridges, and closed linear depressions (Wallace, 1990). The 1906 earthquake resulted from rupture of the fault from San Juan Bautista north to Point Delgada, a distance of approximately 475 km. The average amount of slip on the fault during this earthquake was 5.1 m in the area to the north of the Golden Gate and 2.5 m in the Santa Cruz Mountains (WGNCEP, 1996).

Based on differences in geomorphic expression, fault geometry, paleoseismic chronology, slip rate, seismicity, and historic fault ruptures, the San Andreas fault is divided into a number of fault segments. Each of these segments is capable of rupturing either independently or in conjunction with adjacent segments. In the Bay Area, these segments include the Santa Cruz Mountains, the Peninsula, and the North Coast segments. These fault segments have calculated maximum earthquakes of **M** 7.2, 7.3, and 7.7, respectively. The North Coast segment may also be subdivided into two shorter segments with a boundary at Point Arena. These northern and southern North Coast segments are capable of generating earthquakes of **M** 7.5 and 7.7, respectively. The North Coast segment, or an adjacent fault branch, was the source of the August 18, 1999 **M** 5.0 earthquake located near Bolinas.

South of the Golden Gate, the fault slip rate is 17 - 3/+ 7 mm/yr (Hall *et al.*, 1999). North of the Golden Gate, the slip rate increases to 24 ± 5 mm/yr (Niemi and Hall, 1992). WGCEP (1999) assigns a recurrence interval of 361 years to a **M** 8.0 1906-type event on the San Andreas fault, with a 21 percent probability of a **M** 6.7 or larger earthquake on the San Andreas in northern California in the time period 2000 to 2030. Recent investigations by Niemi *et al.* (2002) indicate that the repeat time for large earthquakes on the North Coast segment may be less than 250 years.

HAYWARD FAULT

The fault extends for 100 km from the area of Mount Misery, east of San Jose, to Point Pinole on San Pablo Bay. At Point Pinole, the Hayward fault runs into San Pablo Bay. The northern continuation of this fault system is the Rodgers Creek fault. The two faults are separated by a 5-km-wide right step beneath San Pablo Bay (the Rodgers Creek fault is discussed below). Systematic right-lateral geomorphic offsets and creep offset of cultural features have been well documented along the entire length of the fault (Lienkaemper, 1992). The last major earthquake on the Hayward fault, in October 1868, occurred along the southern segment of the fault. This **M** 6.8 event caused toppling of buildings in Hayward and other localities within about 5 km of the fault. The surface rupture associated with this earthquake is thought to have extended for approximately 30 km, from Warm Springs to San Leandro, with a maximum reported displacement of 1 m. The Hayward fault is considered the most likely source of the next major earthquake in the Bay Area (WGCEP, 1999). As well as undergoing displacement earthquake ruptures, the Hayward fault also moves by aseismic creep. Measurements along the fault over the last two decades show that the creep rate is 5 to 9 mm/yr (Lienkaemper and Galehouse, 1997).

Recent research of historical documents has led to the conclusion that an earthquake in 1836, previously thought to have occurred on the northern Hayward fault, occurred elsewhere (Toppozada and Borchardt, 1998), thereby increasing the time since the last earthquake on this segment of the fault. Recent paleoseismic trenching along the northern Hayward fault indicates that the last surface rupturing earthquake along this part of the fault was sometime between 1626 and 1724 (Lienkaemper *et al.*, 1997). This study also indicated at least four surface-rupturing earthquakes in the last 2,250 years. The WGCEP (1999) assigns maximum earthquakes of **M** 6.6 and 6.9, and recurrence intervals of 387 and 371 years, for the northern and southern segments of the Hayward fault, respectively. Rupture of the entire fault zone would generate an earthquake of

M 7.1. Using more recent rupture area – magnitude relationships, we assign **M** 6.9, 7.1, and 7.3 to rupture of the northern and southern segments, and entire Hayward fault, respectively. We also incorporate a third Hayward fault segment – the southeast extension – that has an estimated maximum earthquake of **M** 6.5. This part of the fault only has a slip rate of 3 ± 2 mm/yr. The WGCEP (1999) considers the Hayward-Rodgers Creek fault system the most likely source of the next **M** 6.7 or larger earthquake in the Bay Area, with a 32 percent probability of occurring in the time period 2000 to 2030. Our model also incorporates a scenario where the Hayward fault ruptures along with the Rodgers Creek fault. Rupture of the entire length of both faults would generate a maximum earthquake of **M** 7.6. Rupture of the Rodgers Creek fault and the northern segment of the Hayward fault would generate a maximum event of **M** 7.4.

HAYWARD SOUTHEAST EXTENSION

The northeastern margin of Santa Clara Valley, including Evergreen Valley, is marked by a northeast-dipping sequence of thrusts that are part of the East Bay Hills structural domain (Aydin and Page, 1984) or Graymer's (1995) Fremont subzone of the southern Hayward fault. This sequence of southwest-verging, reverse faults is located in the restraining left-step between the Calaveras and Hayward faults. The faults include the Piercy, Coyote Creek, Silver Creek, Evergreen, Quimby, Berryessa, Crosley, and Warm Springs faults. Like the Foothill thrust belt on the western side of Santa Clara Valley, this series of reverse and reverse-oblique faults marks the margin of a region of rapid late Cenozoic uplift. The Crosley, Berryessa, and Warm Springs faults have been interpreted as structures that may transfer slip from the southern Hayward fault to the Calaveras fault (Graymer *et al.*, 1995). Jones *et al.* (1994) show these faults as a steeply dipping zone of thrusts that roots in the Calaveras fault at an approximately 6.2 mile (10 km) depth. Outcrop mapping, however, suggests that many of these faults are moderate to relatively low-angle features that may root into the Calaveras fault at shallower depths. The thrust fault traces are slightly oblique, rotated about 10º to 15º counterclockwise, to the main strike-slip faults.

Although seismicity in this area is diffuse, relocation of microearthquake epicenters indicates that contemporary seismicity may be associated with faults that dip moderately to the east (Woodward-Clyde Consultants, 1994). Earthquake focal mechanisms also indicate northwest-striking reverse faulting. No large, historical earthquakes have been conclusively attributed to the thrust faults along the eastern Santa Clara Valley margin (Oppenheimer *et al.*, 1990). Jaumé and Sykes (1996) suggest that the July 1, 1911, **M** 6.2 earthquake may have occurred on a thrust fault parallel to the Calaveras fault; however, macroseismic intensity data indicate that this event is more likely to have occurred on the Calaveras fault (Bakun, 1999; Toppozada, 1984). The recent activity of many of these faults is inconclusive, and in some cases it is unclear whether the mapped trace is of tectonic or landslide origin. The range front along the northeastern side of Santa Clara Valley is modified by many large-scale slope failures.

The Evergreen fault is typical of faults in this area. This fault is an east-dipping reverse or reverse-oblique fault striking northwest across the piedmont of Evergreen Valley, east of San Jose. A recent trenching investigation at this site showed that the Evergreen fault is a moderate to low-angle (less than 45º) thrust fault, displacing Knoxville shale, up to the east, against gravels of the Santa Clara Formation (Fenton *et al.*, 1995). The fault plane was observed to cut up through the gravels and paleosol horizons estimated to be late Pleistocene in age. Overlying gravels were also observed to have been warped. The trench exposures were interpreted as indicating that the Evergreen fault had experienced coseismic rupture during the late Pleistocene, but that this rupture had not propagated to the surface. Rather, it had just resulted in warping of the ground surface. Slickensides on the fault surface indicated that fault slip was not purely reverse, but incorporated a small component of lateral movement.

The WGNCEP (1996) assigned a maximum earthquake of **M** 6.4 with a recurrence interval of 220 years for the Hayward Southeast Extension. The WGCEP (2003) does not include the Hayward Southeast Extension in its evaluation of earthquake probabilities in the San Francisco Bay Area.

RODGERS CREEK FAULT

As indicated previously, the Hayward fault runs into San Pablo Bay at Point Pinole. The northern continuation of this fault system is the Rodgers Creek fault. The two faults are separated by a 5-km-wide right step beneath San Pablo Bay. The Rodgers Creek fault is 44 km long and has a similar geomorphic expression to the Hayward. At its northern end, the Rodgers Creek fault is separated from the Healdsburg fault by a 3-km-wide right step, and separated from the Maacama fault by a 10-km-wide right step (Wagner and Bortugno, 1982). Holocene activity along the Rodgers Creek is indicated by a series of fault scarps in Holocene deposits, side-hill benches, right-laterally offset streams, and closed linear depressions. Microseismicity is nearly absent along much of the length of the fault suggesting that it is a seismic gap and the site of an impending earthquake (Wong, 1991). Paleoseismic investigations by Schwartz *et al.* (1992) revealed three events in 925 to 1,000 years. This gives a preferred recurrence of 230 years for a maximum earthquake of **M** 7.2. The most recent earthquake occurred on the fault sometime between 1438 to 1654 AD (Schwartz *et al.*, 1992). The calculated slip rate for the Rodgers Creek fault is 9 ± 2 mm/yr.

FOOTHILL THRUST BELT

The southwestern margin of the Santa Clara Valley is bounded by the rugged, young southern Santa Cruz Mountains. Late Cenozoic uplift of the mountains has occurred, in part, along a series of northwest-striking reverse faults, known as either the Loma Prieta domain (Aydin and Page, 1984) or Foothills thrust belt (Bürgmann *et al.*, 1994), bordering the northeastern margin of the range front. Bounded by the main trace of the San Andreas fault to the west, this sequence of southwest-dipping thrusts, associated with a restraining left bend in the San Andreas fault, has been responsible for the uplift of the Santa Cruz Mountains (Bürgmann *et al.*, 1994). These faults offset the Pliocene and Pleistocene Santa Clara Formation, and locally offset and deform overlying Quaternary sediments and geomorphic surfaces within the range-front communities of Palo Alto, Los Altos Hills, Cupertino, Saratoga, and Los Gatos, located along the southwestern margin of the Santa Clara Valley (Hitchcock and Kelson 1999; Hitchcock *et al.* 1994). The up-dip projection of the blind Loma Prieta fault, which is interpreted to have been the source of the 1989 **M** 6.9 Loma Prieta earthquake (Bürgmann *et al.*, 1994), coincides with the Foothills thrust belt.

Historical records indicate that a **M** 6.5 earthquake in 1865 may have occurred on a fault east of the San Andreas fault, possibly along the northeastern flank of the Santa Cruz Mountains (Toppozada and Borchardt, 1998; Tuttle and Sykes, 1992a; Tuttle and Sykes, 1992b). Based on the magnitude of aseismic deformation of the northeastern Santa Cruz Mountains following the 1989 Loma Prieta earthquake, it is possible that a large component of the total slip on the Foothills thrust belt occurs aseismically in association with slip on the nearby San Andreas fault (Hitchcock and Kelson 1999). It is also possible that one or more segments of the system may rupture in a single event, producing a moderate- to large-magnitude earthquake (Zoback *et al.*, 1999).

The Berrocal fault is located along the range front between Saratoga and Los Gatos, and extends for 55 km within the range block. Southeast of Los Gatos, the Berrocal fault merges with, or intersects, the Sargent fault. To the northwest, the fault either dies out or merges with the Monte Vista fault. The Berrocal fault is also linked to the San Andreas fault by the north-striking Lexington fault along Los Gatos Creek. Scattered seismicity along and to the southwest of the mapped fault trace may be related to either the Berrocal fault, or a related northeast-vergent blind thrust fault. Significant compressional surface deformation was observed along the Berrocal fault in the Los Gatos and Saratoga areas during the Loma Prieta earthquake (Langenheim *et al.*, 1997).

The 54-km-long Monte Vista fault is one of the primary range-front faults and probably the most extensively studied fault in the Foothills thrust belt. The exposed fault strikes northwest and places Franciscan, Miocene, Santa Clara Formation, and Pleistocene alluvium over Pleistocene and older strata. To the south, the fault merges with the Shannon fault, while at its northern end it intersects the San Andreas, via the Hermit fault, between Woodside and Redwood City. Limited exploratory trenching indicates that the Monte Vista fault has had late Quaternary and possibly Holocene displacement. Recent geomorphic mapping by Hitchcock *et al.* (1994) shows that late Pleistocene fluvial terraces flanking Stevens Creek are deformed. The style of late Quaternary deformation affecting these terrace surfaces is consistent with reverse faulting on the Monte Vista fault. Hitchcock and Kelson (1999) estimated an average late Pleistocene slip rate of 0.17 ± 0.09 mm/yr for the Monte Vista fault.

The Shannon fault, which extends from near Saratoga, south to Coyote Creek near New Almaden, consists of several *en echelon*, southwest-dipping, thrust or reverse fault strands and several subsidiary northeast-dipping normal fault strands. Geomorphic investigations provide evidence of probable late Pleistocene deformation associated with these southwest-dipping, northeast-vergent reverse fault strands (Hitchcock *et al.*, 1994). Trench exposures at the Senator mine west of New Almaden show that the southern segment of the Shannon fault deforms Miocene rock and cuts a paleosol with an estimated age less than 20,000 years (R. McLaughlin, U.S. Geological Survey, *pers. comm.*, to C. Hitchcock, WLA, 1993). As with the Berrocal, Sargent, and Monte Vista faults, compressional surface deformation was locally concentrated along the Shannon fault, in the Los Gatos and Campbell areas, during the Loma Prieta earthquake.

The Cascade fault traverses the coalescent alluvial-fan complex underlying the Santa Clara Valley approximately 2 to 6 km northeast of the Santa Cruz Mountains range front. Hitchcock *et al.* (1994) show a strong correlation between the mapped trace of the Cascade fault and fault-related geomorphic features, including vegetation lineaments, closed depressions, linear drainages, stream profile convexities, and high-sinuosity stream reaches. These features are developed in late Pleistocene and possibly Holocene deposits; thus, they provide evidence for late Pleistocene (and possibly Holocene) displacement along the Cascade fault. Between Los Altos Hills and Los Gatos, most of the major streams show longitudinal-profile convexities where they cross the mapped trace of the Cascade fault. In general, the crests of the convexities coincide with the zone of lineaments. These relations indicate late Pleistocene uplift along this section of the Cascade fault (Hitchcock *et al.*, 1994). Although this provides little or no information on the sense of slip and the amount and direction of fault dip, it is likely that the Cascade fault is a southwest-dipping, northeast-vergent reverse fault similar to, but perhaps having a shallower dip in the near surface than the Monte Vista, Berrocal, and Shannon faults.

The faults of the Foothill thrust belt are considered active and capable of generating large-magnitude earthquakes. The Thrust Fault Subgroup of the WGCEP (1999) considered these faults capable of generating earthquakes of **M** 6.2 to 7. Fault slip rates are considered to be in the range 0.2 to 0.8 mm/yr, with 0.5 mm/yr being the preferred estimate. Estimates for the maximum earthquake within this source zone range from **M** 6¼ to 7.

EAST VALLEY THRUST

The East Valley thrusts are a series of northeast-dipping thrust faults that mark the junction between the southern end of the Hayward fault and the southern and central segments of the Calaveras fault. These faults, which include the Piercy, Coyote Creek, Silver Creek, Evergreen, Quimby, Berryessa, Crosley, and Warm Springs faults, are relatively short, less than 30 km long, and appear to merge with the Hayward and Calaveras faults at relatively shallow depths (Jones *et al.*, 1994; Fenton and Hitchcock, 2002).

The faults of the East Valley thrust belt are considered active. Fault slip rates are considered to be in the range 0.05 to 0.5 mm/yr, with 0.2 mm/yr being the preferred estimate. Estimate for the maximum earthquake within this source zone is approximately **M** 6.5.

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
San Andreas	1.0	Unsegmented (0.5)	1906	474 ± 25	15 ± 3	90	N/A	SS	7.9	24 ± 5	Characterization of the SAF based on Working Group on California Earthquake Probabilities (1999). Unsegmented rupture scenario is a repeat of the 1906 M_w 7.9 San Francisco earthquake.
		Two Segments (0.2)	North Coast	327 ± 11	15 ± 3	90	N/A	SS	7.7	24 ± 5	
			Peninsula + Santa Cruz Mountains	147 ± 13	15 ± 3	90	N/A	SS	7.4	17 ± 4	
		Three Segments (0.1)	North Coast	327 ± 11	15 ± 3	90	N/A	SS	7.7	24 ± 5	
			Peninsula	85 ± 13	15 ± 3	90	N/A	SS	7.2	17 ± 4	
			Santa Cruz Mountains	62 ± 8	15 ± 3	90	N/A	SS	7.0	17 ± 4	
		Four Segments (0.1)	North Coast North	137 ± 11	15 ± 3	90	N/A	SS	7.3	24 ± 5	
			North Coast South	190 ± 11	15 ± 3	90	N/A	SS	7.5	24 ± 5	
			Peninsula	85 ± 13	15 ± 3	90	N/A	SS	7.2	17 ± 4	
			Santa Cruz Mountains	62 ± 8	15 ± 3	90	N/A	SS	7.0	17 ± 4	
		Floating Earthquake (0.1)	N/A	N/A	15 ± 3	90	N/A	SS	6.9	24 ± 5	
San Gregorio	1.0	Unsegmented (0.35)	Northern + Southern San Gregorio	175 ± 13	15 ± 3	90	N/A	SS	7.5	1 (0.2) 3 (0.4) 7 (0.4) 10 (0.1)	Characterization of SGF based on WGCEP (1999) model.
		Segmented (0.35)	Northern San Gregorio	109 ± 13	15 ± 3	90	N/A	SS	7.2	7 ± 3	
			Southern San Gregorio	66 ± 10	15 ± 3	90	N/A	SS	7.0	3 ± 2	
		Floating Earthquake (0.3)	N/A	N/A	15 ± 3	90	N/A	SS	6.9	1 (0.2) 3 (0.4) 7 (0.4) 10 (0.1)	

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
Hayward – Rodgers Creek	1.0	Unsegmented (0.05)	Hayward + Rodgers Creek	150 ± 9	15 ± 3	90	N/A	SS	7.3	9 ± 2	Characterization of Hayward – Rodgers Creek fault based on WGCEP (1999) model.
		Two Segment (A) (0.1)	North Hayward + Rodgers Creek	98 ± 9	15 ± 3	90	N/A	SS	7.1	9 ± 2	
			Southern Hayward	52 ± 9	15 ± 3	90	N/A	SS	6.7	9 ± 2	
		Two Segment (B) (0.3)	Rodgers Creek	63 ± 9	15 ± 3	90	N/A	SS	7.0	9 ± 2	
			Hayward	87 ± 9	15 ± 3	90	N/A	SS	7.0	9 ± 2	
		Three Segment (0.5)	Rodgers Creek	63 ± 9	15 ± 3	90	N/A	SS	7.0	9 ± 2	
			North Hayward	35 ± 8	15 ± 3	90	N/A	SS	6.5	9 ± 2	
			Southern Hayward	52 ± 9	15 ± 3	90	N/A	SS	6.7	9 ± 2	
		Floating Earthquake (0.05)	N/A	N/A	15 ± 3	90	N/A	SS	6.9	9 ± 2	
Calaveras	1.0	Unsegmented (0.05)	Northern + Central + Southern Calaveras	118 ± 5	15 ± 3	90	N/A	SS	6.9	4 (0.2) 6 (0.4) 15 (0.3) 20 (0.1)	Characterization of Working Group on California Earthquake Probabilities (1999) modified by recent paleoseismic data of Kelson and Baldwin (2002).
		Two Segments (0.05)	Northern Calaveras	40 ± 5	15 ± 3	90	N/A	SS	6.8	6 ± 2	
			South + Central Calaveras	78 ± 5	15 ± 3	90	N/A	SS	6.4	15 ± 5	
		Three Segments (0.3)	Northern Calaveras	40 ± 5	15 ± 3	90	N/A	SS	6.8	6 ± 2	
			Central Calaveras	59 ± 5	15 ± 3	90	N/A	SS	6.2	15 ± 5	
			Southern Calaveras	19 ± 5	15 ± 3	90	N/A	SS	5.8	15 ± 5	

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
		Segment + Floating Earthquake (0.5)	Northern Calaveras	40 ± 5	15 ± 3	90	N/A	SS	6.8	6 ± 2	
			Floating Earthquake on Central + South Calaveras	78 ± 5	15 ± 3	90	N/A	SS	6.2	15 ± 5	
		Floating Earthquake (0.1)	N/A	N/A	15 ± 3	90	N/A	SS	6.2	4 (0.2) 6 (0.4) 15 (0.3) 20 (0.1)	
Concord – Green Valley	1.0	Unsegmented (0.35)	Concord + Green Valley	56 ± 4	15 ± 3	90	N/A	SS	6.7	5 ± 3	Characterization of Working Group on California Earthquake Probabilities (1999) modified by recent paleoseismic data of Baldwin *et al.* (2001).
		Three Segments (0.1)	Concord	14 ± 4	15 ± 3	90	N/A	SS	6.3	4 ± 2	
			Southern Green Valley	22 ± 3	15 ± 3	90	N/A	SS	6.3	5 ± 3	
			Northern Green Valley	20 ± 4	15 ± 3	90	N/A	SS	6.0	5 ± 3	
		Two Segments (0.15)	Concord	14 ± 4	15 ± 3	90	N/A	SS	6.3	4 ± 2	
			Green Valley	42 ± 4	15 ± 3	90	N/A	SS	6.5	5 ± 3	
		Two Segments (0.15)	Concord + Southern Green Valley	36 ± 4	15 ± 3	90	N/A	SS	6.6	5 ± 3	
			Northern Green Valley	20 ± 4	15 ± 3	90	N/A	SS	6.0	5 ± 3	
		Floating Earthquake (0.25)	N/A	N/A	15 ± 3	90	N/A	SS	6.2	5 ± 3	

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
Greenville	1.0	Unsegmented (0.35)	Northern + Southern Greenville	73 ± 8	15 ± 3	90	N/A	SS	6.9	4.1 ± 1.8	Characterization of the Working Group on California Earthquake Probabilities (1999) modified by paleoseismic data from Sawyer and Unruh (2002).
		Two Segments (0.35)	Northern Greenville	40 ± 8	15 ± 3	90	N/A	SS	6.7	4.1 ± 1.8	
			Southern Greenville	33 ± 8	15 ± 3	90	N/A	SS	6.6	4.1 ± 1.8	
		Floating (0.3)	N/A	N/A	15 ± 3	90	N/A	SS	6.2	4.1 ± 1.8	
Ortigalita	1.0	Unsegmented (0.3)	Northern + Southern Ortigalita	100 ± 5	15 ± 3	90	N/A	SS	7.4	0.5 (0.15) 1.0 (0.35) 2.0 (0.35) 2.5 (0.15)	Characterization revised from Working Group on California Earthquake Potential (1996) using recent paleoseismic data from Anderson and Piety (2001).
		Segmented (0.35)	Northern Ortigalita	40 ± 5	15 ± 3	90	N/A	SS	7.0	0.5 (0.15) 1.0 (0.35) 2.0 (0.35) 2.5 (0.15)	
			Southern Ortigalita	60 ± 5	15 ± 3	90	N/A	SS	7.2	0.2 (0.5) 1.0 (0.5)	
		Segmented + Floating Earthquake (0.35)	Northern Ortigalita	40 ± 5	15 ± 3	90	N/A	SS	7.0	0.5 (0.15) 1.0 (0.35) 2.0 (0.35) 2.5 (0.15)	
			Floating Earthquake on Southern Ortigalita	60 ± 5	15 ± 3	90	N/A	SS	6.7	0.5 (0.15) 1.0 (0.35) 2.0 (0.35) 2.5 (0.15)	
West Napa	1.0	Unsegmented (0.5)	Northern + Southern West Napa	25 ± 2	15 ± 3	90	N/A	SS	6.8	0.5 (0.2) 1.0 (0.5) 2.0 (0.3)	Characterization based on Working Group on California Earthquake Potential (1996) with modifications based on recent data of J. Wesling, Geomatrix, Inc. (*pers. Comm.*, 2001).
		Segmented (0.5)	Northern West Napa	15 ± 2	15 ± 3	90	N/A	SS	6.6	0.5 (0.2) 1.0 (0.5) 2.0 (0.3)	
			Southern West Napa	10 ± 2	15 ± 3	90	N/A	SS	6.4	0.5 (0.2) 1.0 (0.5) 2.0 (0.3)	

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
Mount Diablo	1.0	Unsegmented (1.0)	North + South Mount Diablo	25 ± 2	15 ± 2	20	NE	R	6.7	1.0 (0.3) 3.0 (0.5) 5.0 (0.2)	Characterization based on Unruh and Sawyer (1997).
Los Medanos fold and thrust belt	1.0	Unsegmented (0.2)	Roe Island + Los Medanos	15 ± 5	18 ± 2	30	NE	R	6.6	0.3 (0.3) 0.5 (0.4) 0.7 (0.3)	Characterization based on Unruh and Hector (1999).
		Segmented (0.8)	Roe Island	5 ± 2	5 ± 2	30	NE	R	5.5 (0.2) 5.75 (0.6) 6.0 (0.2)	0.3 (0.3) 0.5 (0.4) 0.7 (0.3)	
			Los Medanos	10 ± 2	10 ± 2	30	NE	R	5.75 (0.2) 6.0 (0.6) 6.25 (0.2)	0.3 (0.3) 0.5 (0.4) 0.7 (0.3)	
Potrero Hills	1.0	Unsegmented (1.0)	Potrero Hills	9 ± 2	9 ± 2	30 ± 10	SW	R	5.75 (0.3) 6.0 (0.6) 6.25 (0.1)	0.1 (0.2) 0.3 (0.6) 0.6 (0.2)	Characterization based on Unruh and Hector (1999).

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
Pittsburgh-Kirby Hills	1.0	Strike-Slip Model (0.6)	PKHF	20 ± 5	20 ± 5	90	N/A	SS	6.6	0.3 (0.4) 0.5 (0.4) 0.7 (0.2)	Model includes both strike-slip (Unruh and Hector, 1999) and reverse (Weber-Band, 1998) models for fault activity. The former is given greater weight based on the focal mechanisms from contemporary seismicity. Seismogenic depth is significantly greater than elsewhere in the Bay Area.
		Reverse Model (0.4)	PFHF	20 ± 5	28 ± 4	60 ± 15	E	R	6.6	0.1 (0.2) 0.15 (0.6) 0.5 (0.2)	
Midland	0.7	Unsegmented (0.1)	Midland	60 ± 5	15 ± 5	70	W	R	7.1	0.1 (0.2) 0.15 (0.6) 0.5 (0.2)	Activity is inferred from displacement of late Tertiary (and possibly early Pleistocene) strata in seismic reflection profiles.
		Floating Earthquake (0.9)	Midland	20 ± 10	15 ± 5	70	W	R	6 (0.3) 6.25 (0.4) 6.5 (0.3)	0.1 (0.2) 0.15 (0.6) 0.5 (0.2)	
CRSB North of Delta	1.0	Multisegment (0.1)	Mysterious Ridge	35 ± 5	13 ± 2	25 ± 5	W	R	6.9	1.0 (0.7) 3.5 (0.3)	Characterization revised from Working Group on California Earthquake Potential (1996) using data from O'Connell *et al.* (2001).
			Trout Creek + Gordon Valley	38 ± 5	13 ± 2	25 ± 10	W	R	7.0	0.5 (0.3) 1.25 (0.6) 2.0 (0.1)	
		Independent (0.9)	Mysterious Ridge	35 ± 5	13 ± 2	25 ± 5	W	R	6.9	1.0 (0.7) 3.5 (0.3)	
			Trout Creek	20 ± 5	13 ± 2	20 ± 5	W	R	6.7	0.5 (0.3) 1.25 (0.6) 2.0 (0.1)	
			Gordon Valley	18 ± 5	13 ± 2	30 ± 5	W	R	6.5	0.5 (0.3) 1.25 (0.6) 2.0 (0.1)	

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
CRSB South of Delta	1.0	Unsegmented (0.1)	Tracy + Vernalis	69 ± 5	10 ± 2	15	W	R	7.0	0.7 (0.3) 1.5 (0.4) 2.3 (0.3)	Segmentation based on Wakabayashi and Smith (1994) as modified by Working Group on California Earthquake Potential (1996). Segment characteristics from Sowers and Ludwig (2000) and Wakabayashi and Smith (1994).
		Segmented (0.9)	Tracy	45 ± 5	10 ± 2	15	W	R	6.8	0.3 (0.1) 0.4 (0.3) 1.0 (0.2) 1.5 (0.2) 2.3 (0.1)	
			Vernalis	24 ± 5	10 ± 2	15	W	R	6.6	0.7 (0.3) 1.5 (0.4) 2.3 (0.3)	
Foothill thrust belt	1.0	Floating Earthquake (1.0)	N/A	N/A	N/A		SW	R	6.25 (0.3) 6.5 (0.3) 6.75 (0.3) 7.0 (0.1)	0.2 (0.2) 0.5 (0.6) 0.8 (0.2)	Simplified characterization based on WGCEP (1999). Incorporates Berrocal, Shannon-MonteVista, and Cascade faults.
Sargent	1.0	Entire Rupture (1.0)	Sargent	56 ± 5	15 ± 3	45 ± 15	SW	OR	7.1	1.5 (0.3) 3.0 (0.4) 4.5 (0.3)	Characterization based on Working Group on California Earthquake Potential (1996).
Northern East Valley Thrusts	0.5	Unsegmented (1.0)	N/A	32	25±5	30, 45	E	R	6.5	0.05 (0.2) 0.2 (0.6) 0.5 (0.2)	modified from Fenton and Hitchock (2001); simplified characterization of Evergreen, Quimby, Berryessa, Crosley, and Warm Springs faults.
Silver Creek	0.5	Unsegmented (0.3)	N/A	48	23±7	45 ± 15	E	OR	6.5	0.05 (0.2) 0.2 (0.6) 0.5 (0.2)	modified from Fenton and Hitchock (2001); simplified

Table A-2. Seismic Source Parameters

Fault Name	Probability of Activity[1]	Rupture Scenario[2]	Segment Name	Length[3] km	Depth[4] km	Dip[5] degrees	Direction of Dip[6]	Faulting Style[7]	Max Mag[8]	Slip-rate[9] mm/year	Notes
		Two Segments (0.7)	North	27	23±7	45 ± 15	E	OR	6.5	0.05 (0.2) 0.2 (0.6) 0.5 (0.2)	characterization of Silver Creek and related faults
			South	21	23±7	45 ± 15	E	OR	6.5	0.05 (0.2) 0.2 (0.6) 0.5 (0.2)	
Coyote Creek/Piercy	0.5	Unsegmented (1.0)	N/A	43	25±5	30, 45	E	R	6.5	0.05 (0.2) 0.2 (0.6) 0.5 (0.2)	modified from Fenton and Hitchock (2001); simplified characterization of Coyote Creek and Piercy faults
Hayward SE extension	1.0	Unsegmented (1.0)	N/A	26	10 ± 2	90	N/A	RL	6.4	1.0 (0.2) 3.0 (0.6) 5.0 (0.2)	WGCEP (1996); J. Lienkaemper, pers. comm.. 2006

[1] Probability of Activity: Holocene or historical activity (1.0); Late Pleistocene or inferred association with historical seismicity (0.7); activity inferred from fault geometry, considered to potentially rupture under current tectonic regime (0.5).
[2] Weight assigned according to likelihood of occurrence of rupture scenario.
[3] Rupture length in kilometers. Unless otherwise stated, weights are 0.4 for the best estimate and 0.3 for the upper and lower bound estimates.
[4] Down-dip width of fault rupture. Unless otherwise stated, weights are 0.4 for the best estimate and 0.3 for the upper and lower bound estimates.
[5] Inclination of fault plane, measured from the horizontal. Unless otherwise stated, weights are 0.4 for the best estimate and 0.3 for the upper and lower bound estimates.
[6] Direction of inclination of the fault plane. N/A infers a vertical fault plane.
[7] SS – strike-slip; R – reverse; OR – oblique-reverse.
[8] Weights assigned to magnitude estimates shown in parenthesis where applicable.
[9] Slip rate based on paleoseismic data. Unless otherwise stated, weights are 0.4 for the best estimate and 0.3 for the upper and lower bound estimates.